PATENT ABSTRACTS OF JAPAN

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(54) MAGNETORESISTANCE EFFECT FILM, MAGNETORESISTANCE EFFECT ELEMENT, MAGNETIC HEAD AND MAGNETIC RECORDING AND REPRODUCING DEVICE

(57)Abstract:

PURPOSE: To obtain a high rate of change of magnetoresistance even at a relatively low magnetic field by using an amorphous magnetic alloy for at least one layer of a magnetic layer in a magnetoresistance effect layer having a three-layer film and a five-layer film of a magnetic layer and non-magnetic layer or an antiferromagnetic layer on or under the magnetic layer.

CONSTITUTION: The magnetoresistance effect layer having three-layer film laminating the magnetic layer, the non-magnetic layer and the magnetic layer, the five-layer film laminating the magnetic layer, the non-magnetic layer, the magnetic layer, the non-magnetic layer and the magnetic layer or the anti-magnetic layer on or under the magnetic layer is provided. In this effect layer, the high rate of change of the magnetoresistance is obtained at a relatively low magnetic field. That is, it seems that a soft magnetic characteristic is improved when the amorphous magnetic alloy is used. At this time, in a CoFeB layer being the amorphous layer having a rate of change of the magneto-resistance (MR ratio) of 5% for example is obtained within a change of the magnetic field of 280A/m as the center of the magnetic field H of 800A/m, and a magnetic sensitivity becomes to 17.8%KAm-1. That is, the high rate of change of the magnetoresistance is obtained at the relatively low magnetic field.

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CLAIMS

[Claim(s)]

[Claim 1] the magneto-resistive effect film characterized by the above-mentioned magnetic layer having been further alike at least, and using an amorphous magnetism alloy in the magneto-resistive effect film which has an antiferromagnetism layer on the magnetic layer of these 3 layer membrane and five layer membranes, or in the bottom at five layer membranes which carried out the laminating of three layer membranes which carried out the laminating of a magnetic layer, a non-magnetic layer, and the magnetic layer, a magnetic layer, a non-magnetic layer, a magnetic layer, a non-magnetic layer, and the magnetic layer, and a list.

[Claim 2] Magneto-resistive effect film characterized by the include angles which the sense of magnetization of the magnetic layer whose non-magnetic layer is pinched makes in the magneto-resistive effect film according to claim 1 differing mutually.

[Claim 3] Magneto-resistive effect film characterized by at least one layer of the above-mentioned magnetic layer being a Co-Fe-B system amorphous magnetism alloy in the magneto-resistive effect film according

to claim 1 or 2.
[Claim 4] Magneto-resistive effect film characterized by B concentration of the above-mentioned Co-Fe-B system amorphous magnetism alloy being 10 - 25at% in the magneto-resistive effect film according to claim 3.
[Claim 5] Magneto-resistive effect film characterized by being the alloy with which at least one layer of a magnetic layer uses Co, nickel-Fe, or nickel-Fe-Co as a principal component in the magneto-resistive effect film of four given in any 1 term from claim 1.
[Claim 6] Magneto-resistive effect film characterized by at least one layer of the above-mentioned non-magnetic layer being Cu, Ag, or Au in the magneto-resistive effect film of five given in any 1 term from claim 1.
[Claim 7] Magneto-resistive effect film characterized by the include angles which the easy direction of magnetization produced from claim 1 from the magnetic anisotropy of the magnetic layer whose non-magnetic layer is pinched in the magneto-resistive effect film of six given in any 1 term makes differing.
[Claim 8] the magneto-resistive effect film characterized by preparing the diamagnetism layer which the magnetic layer of the magneto-resistive effect film of seven given in any 1 term is further alike at least from claim 1, and impresses an exchange bias field.
[Claim 9] The magneto-resistive effect component characterized by using the magneto-resistive effect film of eight given in any 1 term at least for a part from claim 1.
[Claim 10] The magnetic head which used the magneto-resistive effect component according to claim 9 at least for the part.
[Claim 11] The compound-die magnetic head which combined the magnetic head and the induction type magnetic head according to claim 10.
[Claim 12] The magnetic recorder and reproducing device using the magnetic head according to claim 10 or 11.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the magneto-resistive effect film which has a high magneto-resistive effect by the low field, the magneto-resistive effect component using this magneto-resistive

effect film, the magnetic head using this component, and the magnetic recorder and reproducing device using this magnetic head.
[0002]
[Description of the Prior Art] Conventionally, the permalloy was used as magneto-resistive effect material of the magnetic head for playback. However, the magnetic-reluctance rate of change of a permalloy was as low as about 3%, and the ingredient of magnetic-reluctance rate of change still higher than this was called for. The Fe/Cr magnetic film which has multilayer structure as an ingredient with magnetic-reluctance rate of change higher than this permalloy was proposed, and the Ta/NiFe/Cu/NiFe/FeMn/Ta film was also proposed.
[0003]
[Problem(s) to be Solved by the Invention] However, the Fe/Cr magnetic film with the above-mentioned multilayer structure was not able to be used for a magneto-resistive effect component with the required high field of 800 kA/m, and required operating by the low field, and the magnetic head, in order to acquire sufficient magnetic-reluctance rate of change. Moreover, although the Ta/NiFe/Cu/NiFe/FeMn/Ta film showed 2.2% of magnetic-reluctance rate of change by the low field comparatively, still it was not enough and the ingredient in which higher magnetic-reluctance rate of change is shown by the low field was called for. This invention aims at offering the magneto-resistive effect film in which higher magnetic-reluctance rate of change is shown by the low field, a magneto-resistive effect component, the magnetic head, and a magnetic recorder and reproducing device.
[0004]
[Means for Solving the Problem] in order to attain the above-mentioned object, in this invention, it is the above-mentioned magnetic layer's having been further alike at least, and having used the amorphous magnetism alloy on five layer membranes which carried out the laminating of three layer membranes which carried out the laminating of a magnetic layer, a non-magnetic layer, and the magnetic layer, a magnetic layer, a non-magnetic layer, a magnetic layer, a non-magnetic layer, and the magnetic layer, or a magnetic layer, or for the bottom in the magneto-resistive effect film which has an antiferromagnetism layer. Moreover, the above-mentioned magneto-resistive effect film is the include angle which the sense of magnetization of the magnetic layer whose non-magnetic layer's is pinched makes changing, and having used the above-mentioned amorphous magnetism alloy as the Co-Fe-B system amorphous magnetism alloy whose B concentration's is 10 - 25at%. Moreover, at least one layer of the magnetic layer of the above-mentioned magneto-

resistive effect film is the alloy which uses Co, nickel-Fe, or nickel-Fe-Co as a principal component, and it is having set at least one layer of the above-mentioned non-magnetic layer to Cu, Ag, or Au.
[0005] moreover, it is having given the antiferromagnetism layer which the include angles which the easy direction of magnetization produced from the magnetic anisotropy of the magnetic layer whose non-magnetic layer of the above-mentioned magneto-resistive effect film is pinched makes differ, and the magnetic layer of the magneto-resistive effect film is further alike at least, and impresses an exchange bias field. Moreover, the magneto-resistive effect component of this invention is having used the above-mentioned magneto-resistive effect film for the at least 1 section. Moreover, the magnetic head of this invention is having used the above-mentioned magneto-resistive effect component for the at least 1 section. Furthermore, the magnetic recorder and reproducing device of this invention is having used the above-mentioned magnetic head for the at least 1 section.
[0006] if this invention is explained further -- the amorphous magnetism alloy of this invention -- a Co-Fe-B system amorphous magnetism alloy -- a Co-Fe-B system amorphous magnetism alloy -- B10 - 25at%, Co81 - 67at% and Fe9 - it is a 7.5at% alloy. Moreover, magnetic layers are a metal or alloys, such as Co, nickel-Fe, and nickel-Fe-Co, nickel-Fe consists of 35 - 80% of nickel and Remainder Fe which are known as a permalloy, and nickel-Fe-Co is the thing of 16 - 20% of Fe(s), 66 - 11% of nickel, and 18 - 73% of Co(es). Furthermore, the antiferromagnetism layers of this invention are NiO, NiMn, CoMn, FeMn, etc.
[0007]
[Function] when the above-mentioned magnetic layer boils this invention further at least in the magneto-resistive effect film which has an antiferromagnetism layer on five layer membranes which carried out the laminating of three layer membranes which carried out the laminating of a magnetic layer, a non-magnetic layer, and the magnetic layer, a magnetic layer, a non-magnetic layer, a magnetic layer, a non-magnetic layer, and the magnetic layer, or a magnetic layer, or in the bottom and an amorphous magnetism alloy is used for it, high magnetic-reluctance rate of change is comparatively acquired by the low field. This is considered to be because for soft magnetic characteristics to have improved by using an amorphous magnetism alloy. Moreover, when the magneto-resistive effect component of this invention used the magneto-resistive effect film excellent in the above-mentioned property, and the magnetic head of this invention used the magneto-resistive effect component excellent in the above-mentioned property for the at least 1

section, the thing of a property which was excellent when the magnetic recorder and reproducing device of this invention used the magnetic head excellent in the above-mentioned property for the at least 1 section is obtained again.

[0008]

[Example] Hereafter, the example of this invention is explained. Example 1 following 3 layer membrane and the spin bulb film were produced using RF magnetron sputtering equipment. Ar ** at the time of a spatter is 0.68-1.32Pa, and a film production rate is 0.1 - 0.2 nm/s. Slide glass was used for the substrate, sequential production of an amorphous CoFeB layer, Cu layer, and the Co layer was carried out on it, and the film of CoFeB(6nm)/Cu(2.1nm)/Co (1.5nm) was produced. In addition, the presentation of CoFeB of an amorphous magnetism alloy was B:20at% Fe;8at% Co:72at%. As the property of this film was shown in drawing 1 , magnetic-reluctance rate of change (MR ratio) was acquired for 5% of thing by field change of 280 A/m focusing on the field (H) of 800 A/m, and field sensibility was 17.8%/kAm-1.

[0009] In addition, drawing 1 is the graph which showed H (field of a hard axis) of the above-mentioned film, and the relation of MR ratio (magnetic-reluctance rate of change). Drawing 2 is the graph which showed the field and magnetic-reluctance rate of change of an easy axis of the above-mentioned film, and, as for the upper graph, H of a lower graph expands the zero neighborhood. It is the highly sensitive film, so that the inclination of the magnetic-reluctance rate of change of drawing 2 is large and high. Although the field sensibility of the above-mentioned film was obtained with the ingredient which made the conventional NiFe system alloy the subject, it was it. [of this] [about 3 times] This is considered to be because for soft magnetic characteristics to have improved by having used the amorphous material.

[0010] The film of CoFeB(9nm)/Cu(2.1nm)/Co (1.5nm) was produced by the same approach as example 2 example 1. In addition, the presentation of CoFeB of an amorphous magnetism alloy was B:20at% Fe;8at% Co:72at%. The magnetic-reluctance rate of change of this film was 3%. About this film, when heat treatment was performed at 250 degrees C in the field of 12.8 kA/m for 1 hour, magnetic-reluctance rate of change became high with 4%. It turned out that at least 250 degrees C which is the temperature at which the film is heated in glass welding etc. from this result do not deteriorate. This is considered to be because for there to be no degradation of the property by crystallization of the layer of an amorphous material.

[0011] By the same approach as example 3 example 1, the film of

NiO(50nm)/Co(1.5nm)/Cu(2.1nm)/CoFeB(9nm)/Cu (3nm) with which the exchange bias field from an antiferromagnetism layer was made to be impressed was produced. In addition, the presentation of CoFeB of an amorphous magnetism alloy was B:20at% Fe;8at% Co:72at%. As the property of this film was shown in drawing 3 , magnetic-reluctance rate of change (deltaR/R) was acquired for 2.7% of thing. This value is equivalent to what is obtained with the ingredient which makes the conventional NiFe system alloy a subject, and degradation of a property did not have after 250-degree C heat treatment. Furthermore, it turned out that the exchange bias field is impressed and this film can be used for the application of the magnetic head. in addition, the magnetization curve of this film gets having been shown in drawing 4 , and comes out.

[0012] An example of the magneto-resistive effect component of this invention which used the magneto-resistive effect film of example 4 this invention is shown in drawing 5 . The magneto-resistive effect component of this invention is the thing of the structure which sandwiched the magneto-resistive effect film (1) of this invention with two electrodes (21 22), and sandwiched these in the shielding layer (31 32) from the upper and lower sides.

An example of the rec/play mold magnetic head of this invention which used the magneto-resistive effect component of example 5 this invention is shown in drawing 6 . The rec/play mold magnetic head of this invention is the thing of structure which placed what sandwiched two or more coils (51, 52, and 53) between two magnetic poles (41 42) on the magneto-resistive effect component which consists of the magneto-resistive effect film (1) of this invention, two electrodes (21 22), and a shielding layer (31 32) of two sheets.

[0013] This invention of the ability of various change to be made in the range which does not change a summary is natural, without being limited to an example also in points other than the above.

[0014]

[Effect of the Invention] This invention has the outstanding property that a property does not deteriorate even if a low field shows high magnetic-reluctance rate of change and it is heated by about 250 degrees C, by having made it the above-mentioned configuration.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the graph which showed H (field) of the hard axis of the film of CoFeB(6nm)/Cu(2.1nm)/Co (1.5nm) of this invention, and the relation of MR ratio (magnetic-reluctance rate of change).

[Drawing 2] It is the graph which showed H (field) of the easy axis of the film of drawing 1 , and the relation of MR ratio (magnetic-reluctance rate of change).

[Drawing 3] It is the graph which showed H (field) of NiO(50nm)/Co(1.5nm)/Cu(2.1nm)/CoFeB(9nm)/Cu (3nm) to which the exchange bias field from an antiferromagnetism layer was made to be impressed, and the relation of deltaR/R (magnetic-reluctance rate of change).

[Drawing 4] It is the magnetization curve of drawing 3 .

[Drawing 5] It is the perspective view having shown a part of magneto-resistive effect component of this invention.

[Drawing 6] It is the perspective view having shown a part of rec/play mold magnetic head.

[Description of Notations]

1 Magneto-resistive Effect Film

21 22 Electrode

31 32 Shielding Layer

41 42 Magnetic Pole

51 52 53 Coil

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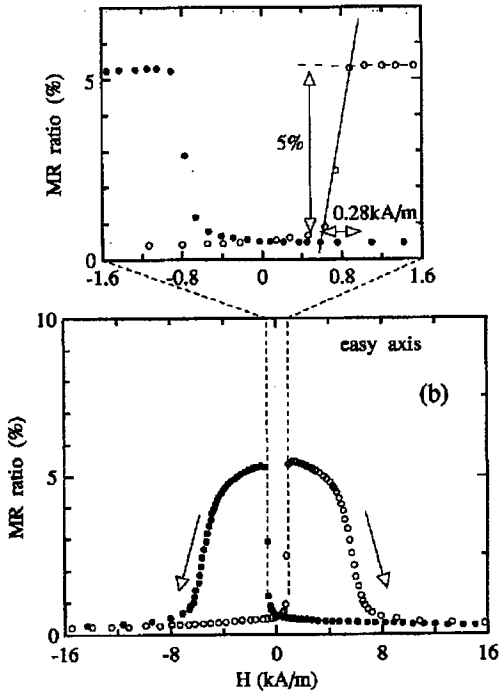
(54)【発明の名称】　磁気抵抗効果膜、磁気抵抗効果素子、磁気ヘッド及び磁気記録再生装置

(57)【要約】

【目的】　低磁界で高い磁気抵抗変化率を示す磁気抵抗効果膜、磁気抵抗効果素子、磁気ヘッド及び磁気記録再生装置を提供すること。

【構成】　磁性層、非磁性層及び磁性層を積層した三層膜、磁性層、非磁性層、磁性層、非磁性層及び磁性層を積層した五層膜、並びにこれら三層膜及び五層膜の磁性層の上又は下に反強磁性層を有する磁気抵抗効果膜において、上記磁性層の少なくとも一層にアモルファス磁性合金を用いた磁気抵抗効果膜、この磁気抵抗効果膜を用いた磁気抵抗効果素子、この素子を用いた磁気ヘッド及びこの磁気ヘッドを用いた磁気記録再生装置。



【特許請求の範囲】

【請求項１】　磁性層、非磁性層及び磁性層を積層した三層膜、磁性層、非磁性層、磁性層、非磁性層及び磁性層を積層した五層膜、並びにこれら三層膜及び五層膜の磁性層の上又は下に反強磁性層を有する磁気抵抗効果膜において、上記磁性層の少なくとも一層にアモルファス磁性合金を用いたことを特徴とする磁気抵抗効果膜。

【請求項２】　請求項１記載の磁気抵抗効果膜において、非磁性層を挟む磁性層の磁化の向きのなす角度が互いに異なったものであることを特徴とする磁気抵抗効果膜。

【請求項３】　請求項１又は請求項２記載の磁気抵抗効果膜において、上記磁性層の少なくとも一層がＣｏ―Ｆｅ―Ｂ系アモルファス磁性合金であることを特徴とする磁気抵抗効果膜。

【請求項４】　請求項３記載の磁気抵抗効果膜において、上記Ｃｏ―Ｆｅ―Ｂ系アモルファス磁性合金のＢ濃度が１０～２５ａｔ％であることを特徴とする磁気抵抗効果膜。

【請求項５】　請求項１から４のいずれか１項記載の磁気抵抗効果膜において、磁性層の少なくとも１層がＣｏ、Ｎｉ―ＦｅあるいはＮｉ―Ｆｅ―Ｃｏを主成分とする合金であることを特徴とする磁気抵抗効果膜。

【請求項６】　請求項１から５のいずれか１項記載の磁気抵抗効果膜において、上記非磁性層の少なくとも一層がＣｕ、Ａｇ又はＡｕであることを特徴とする磁気抵抗効果膜。

【請求項７】　請求項１から６のいずれか１項記載の磁気抵抗効果膜において、非磁性層を挟む磁性層の磁気異方性より生じる磁化容易方向のなす角度が異なっていることを特徴とする磁気抵抗効果膜。

【請求項８】　請求項１から７のいずれか１項記載の磁気抵抗効果膜の磁性層の少なくとも一層に交換バイアス磁界を印加する反磁性層を設けたことを特徴とする磁気抵抗効果膜。

【請求項９】　請求項１から８のいずれか１項記載の磁気抵抗効果膜を少なくとも一部に用いたことを特徴とする磁気抵抗効果素子。

【請求項10】　請求項９記載の磁気抵抗効果素子を少なくとも一部に用いた磁気ヘッド。

【請求項11】　請求項10記載の磁気ヘッドと誘導型磁気ヘッドを組み合わせた複合型磁気ヘッド。

【請求項12】　請求項10又は請求項11記載の磁気ヘッドを用いた磁気記録再生装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、低磁界で高い磁気抵抗効果を有する磁気抵抗効果膜、この磁気抵抗効果膜を用いた磁気抵抗効果素子、この素子を用いた磁気ヘッド及びこの磁気ヘッドを用いた磁気記録再生装置に関する。

【０００２】

【従来の技術】従来、再生用磁気ヘッドの磁気抵抗効果材としてパーマロイが使用されていた。しかし、パーマロイの磁気抵抗変化率は約３％と低く、これよりさらに高い磁気抵抗変化率の材料が求められていた。このパーマロイより磁気抵抗変化率が高い材料として多層構造を持つＦｅ／Ｃｒ磁性膜が提案され、また、Ｔａ／ＮｉＦｅ／Ｃｕ／ＮｉＦｅ／ＦｅＭｎ／Ｔａ膜も提案されていた。

【０００３】

【発明が解決しようとする課題】しかし、上記多層構造を持つＦｅ／Ｃｒ磁性膜は、十分な磁気抵抗変化率を得るために、８００ＫＡ／ｍもの高い磁界が必要であり、低い磁界で動作することが必要な磁気抵抗効果素子、磁気ヘッドに使用することができなかった。また、Ｔａ／ＮｉＦｅ／Ｃｕ／ＮｉＦｅ／ＦｅＭｎ／Ｔａ膜は比較的低磁界で２．２％の磁気抵抗変化率を示しているが、まだ十分でなく、低磁界でより高い磁気抵抗変化率を示す材料が求められていた。本発明は、低磁界でより高い磁気抵抗変化率を示す磁気抵抗効果膜、磁気抵抗効果素子、磁気ヘッド及び磁気記録再生装置を提供することを目的とする。

【０００４】

【課題を解決するための手段】上記目的を達成するために、本発明においては、磁性層、非磁性層及び磁性層を積層した三層膜、磁性層、非磁性層、磁性層、非磁性層及び磁性層を積層した五層膜、若しくは磁性層の上又は下に反強磁性層を有する磁気抵抗効果膜において、上記磁性層の少なくとも一層にアモルファス磁性合金を用いたことである。また、上記磁気抵抗効果膜は非磁性層を挟む磁性層の磁化の向きのなす角度が変化するものであり、上記アモルファス磁性合金をＢ濃度が１０～２５ａｔ％であるＣｏ―Ｆｅ―Ｂ系アモルファス磁性合金としたことである。また、上記磁気抵抗効果膜の磁性層の少なくとも１層がＣｏ、Ｎｉ―ＦｅあるいはＮｉ―Ｆｅ―Ｃｏを主成分とする合金であり、上記非磁性層の少なくとも一層をＣｕ、Ａｇ又はＡｕとしたことである。

【０００５】また、上記磁気抵抗効果膜の非磁性層を挟む磁性層の磁気異方性より生じる磁化容易方向のなす角度が異なっており、磁気抵抗効果膜の磁性層の少なくとも一層に交換バイアス磁界を印加する反強磁性層を付与したことである。また、本発明の磁気抵抗効果素子は、上記磁気抵抗効果膜を少なくとも１部に使用したことである。また、本発明の磁気ヘッドは、上記磁気抵抗効果素子を少なくとも１部に使用したことである。さらに、本発明の磁気記録再生装置は、上記磁気ヘッドを少なくとも１部に使用したことである。

【０００６】本発明をさらに説明すると、本発明のアモルファス磁性合金はＣｏ―Ｆｅ―Ｂ系アモルファス磁性合金でＣｏ―Ｆｅ―Ｂ系アモルファス磁性合金は、Ｂ１

0～25at%、Co81～67at%、Fe9 ～7．5at%の合金である。また、磁性層は、Co、Ni—Fe、Ni—Fe—Coなどの金属又は合金で、Ni—Feはパーマロイとして知られているNi35～80%、残部Feからなるもので、Ni—Fe—CoはFe16～20%、Ni66～11%、Co18～73%のものである。さらに、本発明の反強磁性層は、NiO、NiMn、CoMn、FeMnなどである。

【0007】

【作用】本発明は、磁性層、非磁性層及び磁性層を積層した三層膜、磁性層、非磁性層、磁性層、非磁性層及び磁性層を積層した五層膜、若しくは磁性層の上又は下に反強磁性層を有する磁気抵抗効果膜において、上記磁性層の少なくとも一層にアモルファス磁性合金を用いることにより、比較的低磁界で高い磁気抵抗変化率が得られる。これは、アモルファス磁性合金を用いることにより、軟磁気特性が向上したためであると考えられる。また、本発明の磁気抵抗効果素子は上記特性が優れた磁気抵抗効果膜を使用したことにより、本発明の磁気ヘッドは上記特性が優れた磁気抵抗効果素子を少なくとも1部に使用したことにより、また本発明の磁気記録再生装置は上記特性が優れた磁気ヘッドを少なくとも1部に使用したことにより優れた特性のものが得られる。

【0008】

【実施例】以下、本発明の実施例について説明する。

実施例1

下記三層膜とスピンバルブ膜は高周波マグネトロンスパッタ装置を用いて作製した。スパッタ時のAr圧は0．68～1．32Paで、製膜速度は0．1～0．2nm／sである。基板にスライドガラスを用い、その上にアモルファスCoFeB層、Cu層、Co層を順次作製し、CoFeB（6nm）／Cu（2．1nm）／Co（1．5nm）の膜を作製した。なお、アモルファス磁性合金のCoFeBの組成は、Co：72at%、Fe；8at%、B：20at%であった。この膜の特性は、図1に示したように磁気抵抗変化率（MR ratio）が5%のものが800A／mの磁界（H）を中心として280A／mの磁界変化で得られ、磁界感度は17．8%／kAm^{-1}であった。

【0009】なお、図1は、上記膜のH（磁化困難軸の磁界）とMR ratio（磁気抵抗変化率）の関係を示したグラフである。図2は、上記膜の磁化容易軸の磁界と磁気抵抗変化率を示したグラフで、上のグラフは下のグラフのHが0付近を拡大したものである。図2の磁気抵抗変化率の傾きが大きくて高いほど感度がよい膜である。上記膜の磁界感度は従来のNiFe系合金を主体とした材料で得られるものの約3倍であった。これはアモルファス材料を使用したことにより軟磁気特性が向上したためであると考えられる。

【0010】実施例2

実施例1と同様な方法によりCoFeB（9nm）／Cu（2．1nm）／Co（1．5nm）の膜を作製した。なお、アモルファス磁性合金のCoFeBの組成は、Co：72at%、Fe；8at%、B：20at%であった。この膜の磁気抵抗変化率は3%であった。この膜を12．8kA／mの磁界中で250℃で1時間熱処理を行ったところ、磁気抵抗変化率は4%と高くなった。この結果から膜がガラス融着などにおいて加熱される温度である250℃でも劣化しないことが分かった。これはアモルファス材料の層の結晶化による特性の劣化がないからであると考えられる。

【0011】実施例3

実施例1と同様な方法で、反強磁性層からの交換バイアス磁界が印加されるようにしたNiO（50nm）／Co（1．5nm）／Cu（2．1nm）／CoFeB（9nm）／Cu（3nm）の膜を作製した。なお、アモルファス磁性合金のCoFeBの組成は、Co：72at%、Fe；8at%、B：20at%であった。この膜の特性は、図3に示したように磁気抵抗変化率（ΔR／R）が2．7%のものが得られた。この値は従来のNiFe系合金を主体とする材料で得られるものと同等であり、また250℃の熱処理後も特性の劣化はなかった。さらに、この膜は、交換バイアス磁界が印加されており、磁気ヘッドの用途に使用することができることが分かった。なお、この膜の磁化曲線は図4に示したとうりである。

【0012】実施例4

本発明の磁気抵抗効果膜を使用した本発明の磁気抵抗効果素子の一例を図5に示す。本発明の磁気抵抗効果素子は、本発明の磁気抵抗効果膜（1）を、2個の電極（2_1、2_2）で挟み、これらを上下からシールド層（3_1、3_2）で挟んだ構造のものである。

実施例5

本発明の磁気抵抗効果素子を使用した本発明の録再型磁気ヘッドの一例を図6に示す。本発明の録再型磁気ヘッドは、本発明の磁気抵抗効果膜（1）、2個の電極（2_1、2_2）、2枚のシールド層（3_1、3_2）からなる磁気抵抗効果素子の上に2個の磁極（4_1、4_2）の間に複数のコイル（5_1、5_2、5_3）を挟んだものを置いた構造のものである。

【0013】本発明は、上記以外の点においても実施例に限定されることなく、要旨を変更しない範囲において種々の変更をすることが出来ることはもちろんである。

【0014】

【本発明の効果】本発明は、上記構成にしたことにより、低磁界で高い磁気抵抗変化率を示し、また250℃程度に加熱されても特性が劣化しないという優れた特性を有する。

【図面の簡単な説明】

【図1】　本発明のCoFeB（6nm）／Cu（2．

1nm）／Co（1．5nm）の膜の磁化困難軸のH（磁界）とMR ratio（磁気抵抗変化率）の関係を示したグラフである。

【図2】　図1の膜の磁化容易軸のH（磁界）とMR ratio（磁気抵抗変化率）の関係を示したグラフである。

【図3】　反強磁性層からの交換バイアス磁界が印加されるようにしたNiO（50nm）／Co（1．5nm）／Cu（2．1nm）／CoFeB（9nm）／Cu（3nm）のH（磁界）とΔR／R（磁気抵抗変化率）の関係を示したグラフである。

【図4】　図3の磁化曲線である。

【図5】　本発明の磁気抵抗効果素子の一部を示した斜視図である。

【図6】　録再型磁気ヘッドの一部を示した斜視図である。

【符号の説明】

1　磁気抵抗効果膜

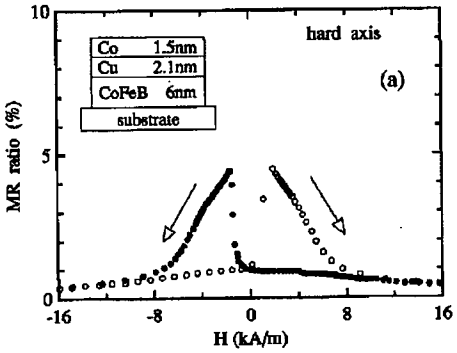
2_1、2_2　電極

3_1、3_2　シールド層

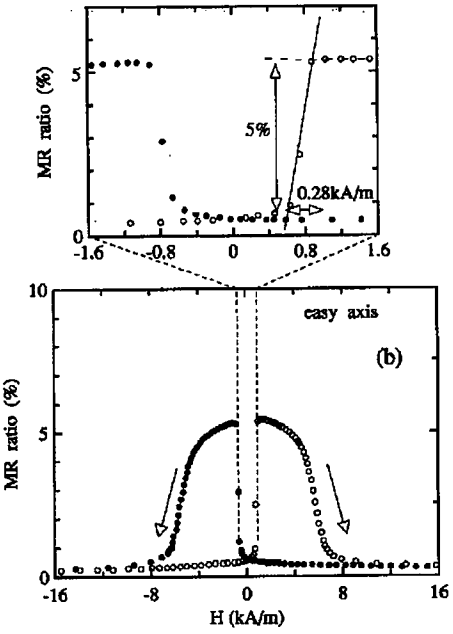
4_1、4_2　磁極

5_1、5_2、5_3　コイル

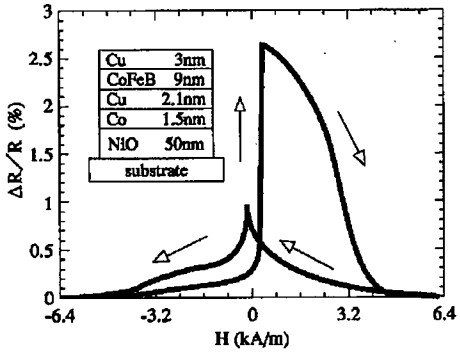
【図1】



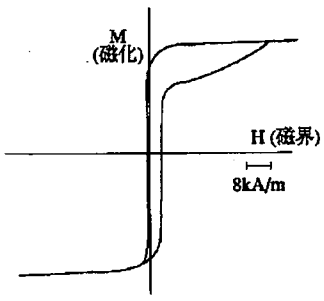
【図2】



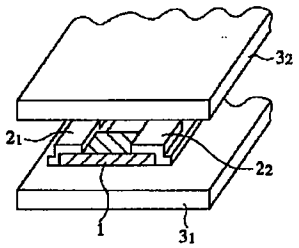
【図3】



【図4】



【図5】



【図6】